again there is no note of warning. Assuming, for the moment, that floats give a trustworthy record of the movement of the surface water in which they are immersed, they give little information about the real motion of any body of water in their course. A single example must suffice to illustrate this. Set a float adrift in the Gulf of Mexico, and it is found in the Shetland Islands; we cannot conclude that water has come from the Gulf of Mexico to the Shetlands—the current which brought the float to the banks of Newfoundland may have there become an under-current, and the float cannot follow it; it remains on the surface, and is borne eastward by water which may have come from Davis Strait or Denmark Strait, where no floats are set adrift. No doubt the fact that the float took the course it did is interesting, and with sufficient knowledge of the mechanism, obtained from other sources, it may be of great value; but even in a simple case, like that quoted, the greatest caution must be exercised, and the uncertainty becomes still greater in channels and enclosed seas.

It seems fair, from Dr. Schott's discussion, to conclude that observations by means of floats are likely to contribute valuable additions to our knowledge of the surface movements of the waters of the sea, when taken in conjunction with systematic observations by more precise methods, of which the distribution of temperature and salinity is probably the most satisfactory. Taken by themselves, the float observations are liable to be seriously misleading. H. N. D.

A COMPARATIVE STUDY OF VISUAL ACCOMMODATION.

So recently as five years ago but little was known with certainty regarding the refraction and accommodation in animals with "camera eyes." It is Beer's[1] credit to have made an exhaustive investigation of a large number of animals with the aid of all modern ophthalmic methods, in addition to an experimental method of his own devising, namely, electrical stimulation of the enucleated eye.

No mechanism for accommodation is known in the facetted eyes of crabs and insects; according to Exner it is not required. The retina is comparatively thick, and moving an object from 80 cm. to 1 mm. from the eye causes an alteration of but ·01 mm. in the position of the image.

A similar argument was supposed to hold good for the rabbit's eye, even by such a distinguished physiologist as Magendie; but this was due to an experimental error. Kepler, although ignorant of accommodation, recognised, nevertheless, that the image on the retina must be sharp for visual purposes.

Speaking generally, an eye must be able to accommodate proportionally to (1) its own size, (2) the width of the pupil, (3) the closeness of the retinal mosaic. Whilst, therefore, an emmetropic man can see plainly at 6 m. without exercising his accommodation, those animals —and there are many—with much larger eyes must, for the same acuity of vision, already accommodate at that distance. On the other hand, it is not so important for large animals to have so near a "near-point" as small animals. Small animals, *e.g.* birds, have to see objects clearly even when quite close; they require a large range of accommodation. Larger animals, except monkey and man, who bring things close to the eye with the hand, can get on with a "near-point" of 1–½ m., corresponding to a range of accommodation of 1–2 diopters; this is so with the horse and ruminants.

Three modes of accommodation are possible: (1) alteration in the refractive power of the various media; (2) alteration of the curvature of the refracting surfaces; (3) alteration of the relative position of lens and retina.

This first method, by which Grimm in 1785 sought to explain accommodation, has never been actually observed. The last was formerly a favourite theory. It was taken up by Kepler and by Scheiner. Many absurd reasons were given, and mechanical hypotheses constructed by various individuals to support this theory; nobody thought of examining the actual facts. In certain classes of animals, viz. cephalopoda, fishes, amphibia and reptiles, accommodation is effected by alteration of the distance between lens and retina. In man, however, as in all mammalia, also in birds, lizards and tortoises, this is brought about by alteration in the curvature of the lens.

It is also obvious that active accommodation may be for a near (positive) or for a far (negative) point, viz. the resting eye may be adjusted for distance or proximity respectively.

The dibranchiate cephalopoda are the only invertebrates in which accommodation has been observed; and, although they have "camera eyes," their type, as a whole, is far inferior to that of vertebrates. By retinoscopy it was determined that their eye is normally adjusted for the near-point. The extent of this normal myopia varies between two and (as an extreme limit) ten diopters. The mechanism of accommodation is as follows:—The bulb forms half of a rough ellipsoid. At the equator is a flat, strong cartilaginous ring, separating the anterior flattened portion of the eye from the posterior ellipsoidal part. Behind the ring the sclerotic is comparatively soft and yielding. In the anterior wall of the eye is also a strong muscular ring with radial fibres running from the cartilaginous ring to the ciliary body, which is firmly attached in the equatorial region of the lens. When this muscle contracts it pulls back the whole anterior wall of the eye, including the ciliary body and lens, towards the interior of the eye. The resulting increased pressure would tend to make the bulb of more spherical shape, with consequent increase of distance between lens and retina, but the thinner consistency of the posterior half leads to an actual diminution of the antero-posterior diameter, and consequent approximation of retina to lens. The iris, which lies practically outside the bulb, and also serves as lid, although extremely sensitive to light, takes no part in accommodation.

Teleostean fishes, although the structure of their eye bears a superficial resemblance to that of the cephalopod eye by virtue of the spherical form of the lens, but is in other respects vertebrate in structure, are, nevertheless, myopic and accommodate for distance. The thickness of the retina, with its sensitive layer on the outer side (in the cephalopoda it is on the inner side), introduces a factor which has to be taken into account when estimating the refraction. Thus an apparently hypermetropic eye may prove to be really myopic. The comparative opacity of water, which does not allow of distinct vision for any great distance, accounts for their permanent myopia, but their range of accommodation is sufficient to enable fishes to focus parallel rays on the retina. But since their cornea is not, as was formerly supposed, flattened, when taken out of water they are so highly myopic that the correction which they possess would be of no value or account. The mechanism of the adjustment is different to that of the cephalopoda, and quite different to that of the vertebrata.

Ciliary body, ciliary muscle, zonula, spaces of Fontana do not exist in fish-eyes, and the iris does not glide on the lens, but is generally quite free. The spherical lens is suspended from above by a strong triangular band; below is the structure known as the "companula," which, from its function, Beer re-names the "retractor lentis"; it draws back the lens nearer to the retina during accommodation. This can be seen on electrical stimulation of the recently enucleated bulb, even after removal of the cornea.

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[1] "The Accommodation of the Eye in the Animal Kingdom." By Th. Beer, Lecturer on Comparative Physiology in the University of Vienna.

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Although the muscle is unstriped, it acts quicker than the iris. Accommodation is paralysed by atropin in fishes, but not in cephalopoda.

Even deep-sea fishes, living at a depth where the light does not affect a photographic plate exposed for a whole day, possess an accommodating apparatus.

Amphibians that accommodate, usually do so for near objects; not, however, like most other animals, by altering the curvature of the lens, but by increasing the distance between retina and lens through contraction of the ciliary muscle. This muscle is unstriped, and the rate of accommodation is slow.

Accommodation is altogether absent in frogs. In these, too, the curvature of the cornea is so great, that in water the hypermetropia, for which no correction exists, is as high as twenty-five diopters. Toads, which can more easily than frogs catch worms and near still objects, possess a slight power of accommodation.

Serpents accommodate in a similar manner, but quicker, because instead of a ciliary muscle, which is generally absent, they possess a striped circular muscle inserted in the attachment of the iris. Contraction thereof presses forward the lens, without altering its curvature, towards the cornea. This mechanism of accommodation increases the pressure in the posterior chamber, and is consequently destroyed by opening the latter.

Accommodation is in all such cases effected by *relaxation*, as originally asserted by Helmholtz, not by increased tension, of the suspensory structures of the lens. By this action it becomes more spherical and of shorter focus. This change can be seen to have taken place in some animals even after removal of the supporting ligaments.

Of Amphibians many have a range of accommodation from ten to fifteen diopters. In animals of nocturnal habits accommodation is least developed. It is in birds that it reaches its highest perfection. Crampton's muscle is here the chief factor in producing relaxation, the inner layer of the cornea being pulled *back*, and not the parts behind the ciliary region forward, as in mammals, where the choroid is pulled forward.

It has been supposed that tightening the zonula caused increased pressure in the vitreous, and thereby increased the curvature of the front surface of the lens. Since, however, electrical stimulation of the enucleated cat- or monkey-eye produces nearly identical results, whether the bulb be intact or cut into (in the latter case there can be no increased pressure in the vitreous), this theory can hardly be correct.

Man has the greatest range of accommodation. After him come monkeys (up to ten diopters), then cats and other beasts of prey, and seals. Larger-eyed animals accommodate at a greater distance, but through a lesser range than man. Horses can also accommodate. But many animals, *e.g.* dog, use their noses rather than their eyes to examine near objects.

The anatomical investigations of Hess and Heine have confirmed most of these ophthalmosopic and experimental results.

Thus the two historical inventions of Helmholtz, the ophthalmometer and the ophthalmoscope, are invaluable not only to ophthalmology, but also to comparative physiology.

NOTES.

THE first of the two annual soirées of the Royal Society will be held on Wednesday, May 3. This is the soirée to which gentlemen only are invited.

THE Deputy-Master of the Trinity House, with a committee of Elder Brethren, accompanied by Lord Rayleigh, their scientific adviser, and Captain the Hon. F. C. P. Vereker, of the Board of Trade, arranged to leave London yesterday for Dover, with the object of making an official inspection of the wireless telegraphy system as experimentally in operation between the South Foreland lighthouse and the East Goodwin light vessel.

REUTER'S correspondent at Buenos Ayres reports that despatches received from Punta Arenas, Patagonia, announce the arrival there of the *Belgica* with the members of the Belgian Antarctic Expedition, under the command of Lieutenant de Gerlache. The *Belgica* is said to have remained fast in the ice for two months.

LORD RAYLEIGH and Prof. G. H. Darwin have been elected honorary members of the New York Academy of Sciences.

DR. T. J. J. SEE, who was recently appointed professor of mathematics in the U.S. Naval Observatory, has been nominated as chief of the American Nautical Almanac Office.

PROF. MILNE-EDWARDS, director of the Paris Natural History Museum, and president of the Geographical Society, has received the Grand Cross of the Swedish Order of the Polar Star from King Oscar II.

MR. J. STANLEY GARDINER, Balfour student of the University of Cambridge, and Mr. L. Borradaile have gone to the Island of Minikoi, situated between the Maldive and Laccadive Islands, to study the formation of coral reefs with special reference to the depth at which the reef-building coral organisms live, the food of the coral polyps, the influence of currents upon coral formations and upon the distribution of life near them, and the inter-relationship existing between the various organisms which occur on a coral reef. It is also proposed to survey the Maldive Islands with a view to obtaining information as to their mode of formation. Mr. C. F. Cooper will join the expedition during the summer.

SIR JOHN LUBBOCK, in a letter to Monday's *Times* on the Government Telephone Bill, draws attention to a point that is often lost sight of. He points out that if the telephone becomes national property, not only will the State lose money, but "the results as regards the progress of applied science will, in my judgment, be even more disastrous. Those who have hitherto devoted thought and time, energy and capital, to apply the results of scientific discovery to practical purposes are now told, that while, of course, if their enterprise does not pay, they must bear the loss, on the other hand, if it succeeds, Government will pass an Act of Parliament to deprive them of any advantage." In support of this opinion he quotes the late Mr. Varley as follows:—"The introduction of protectionism in so important an industry as telegraphy has given the postal executive a grip hold of applied electricity, and has enabled them to crush practically out of existence pioneers in telegraphy and applied electricity. English telegraph enterprise no longer exists, and America, which twenty years ago was electrically in the rear of this country, is now England's teacher. At the present time not only does she take premier rank in dynamo-electric developments, but practically all the telegraphic advances which have been made since the passage of the Telegraph Act have originated from American genius." . . . "The sole object I have in view in writing is to bring home to the British public, if I can, the evil consequences of the un-English retrograde policy of converting applied science into a Government trading monopoly." This point should engage the attention of the Society of Telegraph Engineers.

A FEW facts with regard to irrigation in India were mentioned by Lord Curzon on Monday, in replying to an address of welcome from the people of Lyallpur, a new town founded as a result of the Chenab irrigation scheme. The Viceroy pointed

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